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FORTY YEARS OF PLANT PHYSIOLOGY

SOME GENERAL IMPRESSIONS[1]

By Professor EDWIN C. MILLER

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FORTY years ago the work in plant physiology was changing from the old to the new. Those who were interested in the subject were concerned chiefly with the nature of the response of *Mimosa* or similar plants to stimuli of various sorts. In the main, they were not interested at all in any practical or applicable results that might accrue from their investigations. At about the time of my entrance into the field, the conflict between the purist and the practical man was at its height and was being waged bitterly. It is said that some purist when asked of what practical value his findings were in the field of science, replied, "None whatsoever and if I had thought before undertaking the work that they would be of any practical value, I would never have undertaken the investigation." Such a happening may be somewhat exaggerated, but it, nevertheless, illustrates the state of mind of some of the individuals who waged this bitter conflict. This condition illustrates the same spirit that was expressed by the so-called "malefactors of great wealth" who are reputed to have said that "the public could be damned" as far as they were concerned.

The public, rightly or wrongly, may eventually reach the stage where the workers not only in plant physiology, but also in most other lines of scientific work, must show that the results of their labors will contribute to the happiness or advancement of man-

[1] Address of the retiring president of the American Society of Plant Physiologists, December, 1942.
Contribution No. 443, Department of Botany, Kansas Agricultural Experiment Station.

kind before it will consent to grant the request of these workers for pecuniary aid in pursuing any investigation. This reaction of the public has an influence that is felt even in the privately endowed institutions. This attitude of the public may be wrong, but right or wrong, it exists and any one interested in research must reckon with it. The practical aspect now dominates investigational work in all regards and the so-called purist, especially in plant physiology, is now prominent only on account of his absence. Now we say that it was foolish to fuss over such a question for no one can tell when a scientific discovery even of the purist type may become of the utmost practical importance. Let us illustrate this fact from experience.

In 1924 I published a paper in the *Journal of Agricultural Research* entitled, "Daily Fluctuations of the Carbohydrates in the Leaves of Corn and Sorghums." No practical importance was attached to the results at that time and they were believed to have none. The facts were observed and it was considered worth while to give them to the world. Within five years after the appearance of this article, the Dairy Department at Kansas State College noted that silage varied markedly in its acidity. Those who were investigating this problem were worried greatly because they could find no cause for this difference in reaction. Some one in the Dairy Department, however, had read the paper just mentioned and wondered if the amount of carbohydrate in the sorghum plant at the time it was cut might not have some influence upon the acidity of silage. He called the attention of the investigators to the paper and to his surmise relative to the acidity. Further study proved that the time of day at which the plant was cut did have an influence upon the acidity of the silage. A purely scientific discovery thus became a practical one.

Forty years ago the work on the composition and action of enzymes dominated the field of plant physiology. We fully believed that the riddle of the universe would be solved when the nature of their composition and action was discovered. The biological workers have since found and proved many facts relative to the structure and mode of action of enzymes, but the ultimate cause of these problems has never been explained to the satisfaction of the student of plant physiology.

After the study of enzymes there followed that of the water requirement of plants, their point of permanent wilting, drought resistance, root systems, the effect of the H-ion concentration of their cells and of the medium in which they grow, the effect of ultraviolet light on their growth and development, photoperiodism, their resistance to heat and cold, their reaction to the carbohydrate/nitrogen ratio, growth substances, hormones, vitamins and numerous and varied other studies. The investigator may be prone to consider his particular problem one of the most fundamental of those confronting mankind to-day. The solution, however, of each of these problems is yet far distant. The present status of many of these problems can be stated by using the following illustration.

During the second year of our graduate work at Yale University, an extensive publication was discussed in weekly seminars for two months or more. It was a detailed review of the research work that had been done along various allied lines. The author would survey the research that had been completed in each phase, then close with a statement that read somewhat as follows, "Much work yet remains to be done on that subject." This statement was repeated so frequently that it became trite among the graduate students and their instructors.

From the viewpoint of many of us, scientific investigators have never completely solved any problem and it is doubtful if they ever will, even though they keep investigating a problem continuously. Many times, however, they leave the problem upon which they are working to enter what appears to them to be more remunerative fields.

Scientists behave and remind us very much of the actions of youngsters of our boyhood days. The Ohio Canal went within 500 yards of my country home and the boys and girls of that neighborhood fished along it. Suppose a dozen were fishing along its placid bank within a distance of a quarter of a mile. Suddenly one would land a fish larger than those generally caught. Immediately eight or nine of the boys and girls would run to that point to fish and cast their lines into the water. There were no more big fish in that particular spot than elsewhere, but the boys and girls evidently thought so.

Scientists behave relative to their scientific work much as did these boys and girls. Whenever a fellow research worker discovers an outstanding fact, literally hundreds of workers shift their investigations to that field and try to find some phase of it in which to work. We have long noticed the behavior just mentioned and wondered as to the reason why investigators behave as they do. We asked a colleague to explain such behavior. He too had noticed the same trends and had made up his mind on the subject. He replied almost instantly, "The vast majority of scientists do not think for themselves and the discovery of a new fact which promises to be of great importance stimulates them to greater activity. The only way they can show their ability is to follow in the footsteps of the fellow who has demonstrated the ability to think." We are inclined to believe that our colleague was right in his interpretation of the general

behavior of scientists. We may be wrong in our reasoning on the cause of certain fluctuations in trends of research, but most of us will agree that investigational work goes in fads or cycles just as certain styles dominate the wearing apparel of both sexes of the human species. Likewise, we are all agreed that the progress of plant physiology, as in the advancement of all scientific endeavor, is due to the resultant of the efforts of thousands of ordinary investigators and that its progress is not due to the work of any individual or even a small number of workers.

We have also observed during the past forty years that a newly discovered fact seems quite simple in all regards. It is so apparent that we are amazed that it was not discovered long ago! However, as more and more is learned on the subject, it increases in complexity until the solution of the problem which at first appeared so simple is lost beyond recognition because of the complexity of the questions raised by it. Let us consider two cases which illustrate this point. First, let us consider the problem of growth substances. The first discoverer of their action considered that he was working with a single substance. All that needed to be said was that a certain reaction was caused by a *"growth substance."* Then after the problem was further investigated it was found that there were at least three different components of the growth substances, *viz.*, auxin *a*, auxin *b* and heterauxin or indole 3 acetic acid. Then investigators showed that there is a long and varied list of organic compounds that may produce the same effects as these growth substances. Whether the plant secretes all these substances is so far unknown. However that may be, it is certain that when we say "growth substance" at the present time, we must qualify and state the particular substance to which we refer. Thus we have an illustration of a subject that has become more and more complex as investigations have progressed.

The same situation could also be illustrated by considering the discovery of the carbohydrate/nitrogen ratio. This expression was considered a relatively simple one when it was first discussed, but as investigations proceeded, it became more and more complex. The question immediately arose as to the meaning of the expression. To some it meant the total carbohydrate/nitrogen ratio, to others the carbohydrate/insoluble nitrogen ratio, yet others believed that the starch/nitrogen ratio was the one to consider, while others felt that the total carbon/total nitrogen ratio was the important one. This disagreement of the exact ratio to be considered, coupled with the numerous ways by which it might be varied, together with the impossibility of attaining the desired ends because of conditions over which no one has any control, makes it one of the most complex problems for application.

The author has seen much water pass under the bridge in regard to the many problems left unsolved by those working on them. These problems have been deserted because the individual has become disgusted with his lack of progress or has entered new fields of research that seemed more promising. Alas, in most instances he soon finds that he has been chasing a will-o-the-wisp and his new love proves just as cold and unresponsive as the one he deserted. We thus refuse to be excited to any degree by a discovery in plant physiology, although the new discovery is blazoned to revolutionize the efforts of mankind. We are thus frequently the cause of considerable alarm to our young colleagues who have not been through the mill and are not veterans in the service.

We have been impressed with the fact that no problem has ever been totally solved. This point is illustrated by considering the history of the elements that are essential to plant life. The number of elements was formerly designated as ten. This fact was determined and considered settled over fifty years ago. It was so considered because it had been thoroughly proved by experimental methods. The problem, however, was not destined to remain in quiescence for all time. It was later discovered that the investigators had made numerous and varied mistakes in their procedure which induced serious errors in their results. A new series of investigations was then begun on a problem that had long been considered solved. As a result there has been more research work during the past ten years on nutrient solutions, primarily with the idea of determining the elements that are essential to plants, than in any other field of plant physiology save that of growth substances. The results have been most gratifying and, so far, the number of essential elements has been increased from 10 to 12. Several others are yet in dispute. These results should convince all scientific workers of the danger or folly of considering any problem fully solved.

We are convinced from our experience that to be a good investigator, the individual must be in that type of work because he is "born that way." By that we mean that he must be a person who, because of his temperament, likes the investigational type of work and is happy doing it. A good research worker, with but few exceptions, must be patient, a plodder and an individualist with a one-track mind. He must hew to the line and let the chips fall where they may. He must consider that the problem on which he is working, no matter how small it may seem to the average person, is the all-important one and that all others are more or less subsidiary to this one. Thus many scientific investigators could well be classed by their neighbors and compatriots as narrow folks who know little and care less about general affairs. That is perhaps the chief cause for their being irritable and prone

to call a fellow worker names because he has obtained results that differ from theirs under what appear to be similar conditions. This may be illustrated by the well-known work of Eckerson in 1914 on the permeability of the protoplasmic membrane to solutes. She found that the permeability of the cells of roots depended on three main factors which may be listed as follows: (a) on the temperature range considered, (b) upon the type of plasmolyzing agent used, and (c) upon the type of plant.

Let us consider the case of the cells of the radish root, using a solution of potassium nitrate as the plasmolytic agent. She found that from a 10° to 14° C. range of temperature, the permeability of the protoplasm of these cells increased with a rise of temperature; that from 18° to 24° C. the protoplasm of these cells showed no change in its permeability with a fluctuation in temperature; from 24° to 40° C., the permeability of the protoplasm of the cells of this root increased with a rise in temperature; but from 40° to 50° C., the permeability of this protoplasm decreased.

Now suppose one investigator desired to study the influence of temperature on the changes in permeability of the protoplasmic membrane to solutes. Suppose he would choose the radish root and potassium nitrate as the plasmolytic agent and would choose as his range of temperature 18° to 24° C. He would find that the permeability of the protoplasmic membrane would not change over that bloc of temperatures with an increase or decrease in their value. Let us suppose that another investigator would choose the same plant, the same plasmolytic agent, but would choose for the range of temperature 40° to 50° C. He would find that an increase in temperature in that range would decrease the permeability of the protoplasmic membrane to solutes, while a decrease in temperature would increase the permeability. A third investigator might choose the same plant, the same plasmolytic agent, yet choose the range of temperature from 24° to 40° C. in which to work. Inside such a bloc of temperatures he would find that the permeability of the protoplasmic membrane to solutes would increase. Thus under identical conditions except temperature, each investigator would obtain different results. They would all be right. In times past each would have considered the other a fraud or a liar and would not have hesitated to say so publicly.

Privately, we can forgive a research man for speaking hastily because, as previously mentioned, his narrow attitude is one of the characteristics of a good investigator. The public, however, will not be so liberal as to pardon such behavior and will not tolerate such an attitude. We are becoming, whether we like it or not, more and more the servants of the public which is exercising increasing demands on all who in any way may be subject to its will. It looks to its servants for cooperation and leadership. The public in the future will not tolerate any antagonism between research workers. It will see to it that workers in research are congenial to all, including fellow workers. Whether this requirement is better than the old is a moot question in many regards, but right or wrong, the new method is the one that is in the saddle.

We often recall the experience of a former colleague who went to Europe many years ago for advanced study. He planned to "sit in on" the lectures of several noted men in agriculture because he knew professionally of the excellence of their work along special lines. When he arrived abroad he talked with these various professors relative to taking their lectures and all said they would be delighted to have him. Towards the end of his rounds in asking the various professors relative to sitting in on their lectures, he happened innocently and inadvertently to mention that he was also going to take the lectures of Professor X. Instantly the scientist to whom he was talking changed his cordial attitude and bluntly said, "If you listen to the lectures of that man, I will have nothing whatsoever to do with you." The American was nonplussed and had reasons to be so. Practically all American scientists would not hesitate to agree that such an attitude was most damnable. Yet in this country we have attained a similar attitude in many of our institutions of higher learning.

A graduate student who goes to some institution of higher learning soon belongs or is told bluntly that he belongs to such and such a clique. He soon learns that he can not even talk in the hallways to the leader of any other clique or even any of the followers of this man because if he does so, even in the most perfunctory manner, he is immediately marked by a member or the leader of an opposing clique as belonging to the group that opposes them. Such a condition is deplorable, yet it exists to-day in numerous of the large and leading educational institutions of our land. The average graduate student is greatly distressed and bewildered at the whole affair and rightly so. He has been taught that one of the main objectives of an education is to attain a more tolerant attitude towards all subjects and toward all people. He can not leave such ideals even though in scientific training we teach him to know more and more about less and less. To our way of thinking the great keystone in the advancement of science is tolerance to the views of others whether we agree with these views or not.

For almost thirty-five years the writer has been an instructor at Kansas State College and an investigator in the Kansas Agricultural Experiment Station.

That my colleagues and myself within that time have accomplished a few things relative to the teaching of plant physiology and along the line of physiological investigations, we believe no one will deny. We can say truthfully and in all sincerity that no rivalry whatsoever relative to the subject-matter to be investigated exists between the various departments of this institution. We talk without restraint to various members of other departments and ask their advice about work that we are doing. They in turn are free to consult us relative to matters in which they are engaged.

Recently one of our students who had finished his undergraduate work at this institution went to a neighboring university to see about taking graduate work leading to the doctorate. He found, to his consternation, that the botany and the chemistry departments of the institution were at swords' points because each felt that certain members of the other department were transgressing upon their sacred domain. This graduate student came back to our institution a sadder but wiser man. He had not realized until that time that such bitter rivalries exist within educational institutions.

There is unquestionably sufficient truth in any field to satisfy the most arduous workers of all parties. The liquor of our own vintage unquestionably is good but if we should mix the drinks from all sources, we would truly have the real nectar of the gods. We are not a prophet or the son of a prophet, but we predict that unless we quit fussing over tweedledum and tweedledee, the fate of our investigations is sealed, for the public that furnishes us the funds with which to conduct our research will withhold them from those who can not conduct investigations in a cooperative way.

Another fact that has been impressed upon me during forty years of experience is that one may know all about a certain subject and yet be a miserable failure as a teacher. He may be considered a "nut" and no more by his fellow men. We are convinced that to succeed as a teacher, not only in plant physiology, but in any field, two prerequisites are necessary. (a) He must know his subject and keep informed concerning its progress at all times, but (b) he should have common sense. We have frequently been taken to task because we have preached and advocated the last-named characteristics as a prerequisite of success. So far, we have been subjected to no arguments that have in any way whatsoever changed our idea relative to the matter. We would list under the term "common sense" three main factors that we believe make up the meaning of that word: A sense of humor, a knowledge of human nature and a trustfulness in humanity. If any individual possesses these three characteristics to a marked degree and if he, in addition, has a thorough knowledge of his subject, he will succeed as a teacher in his chosen field.

The observations and suggestions that have been listed in this paper are a few that have impressed us in our experience in the field of plant physiology during our forty years of experience in that realm. They are not new thoughts and they have been preached by many from the time that investigational work had its origin. We are convinced that the impressions gathered during our years of experience, if followed even to a limited extent, will benefit both the investigator and the field of plant physiology.

A NEW BLOOD-CLOTTING THEORY

By Dr. JOHN H. FERGUSON

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The difficult subject of blood coagulation has been so beset by inadequacies of the numerous and often conflicting theories, in the light of experimental fact, that the author has labored for nearly a decade with an experimental approach and great hesitancy in propounding a comprehensive theory. Despite the complexities encountered and many "loose-ends" still to be brought into line, current interest in the preparation of plasma and hemostatics for war use makes the time ripe for presentation of a "working hypothesis" for the stimulation of continued research and, particularly, for the guidance of the many whose interest is at present confronted by the sad lack of agreement among so-called "experts" in the field. The experimental basis for the views here presented is to be found in the author's contributions and reviews, in such coagulation reviews as those in *Ergebnisse der Physiologie* (Morawitz, 1905; Wöhlisch, 1929; 1940), in the chapters on proteolytic enzymes and "thrombase" in Oppenheimer's "Die Fermente und ihre Wirkungen" and in Northrop's "Crystalline Enzymes."

It has long been agreed that the essential feature of blood coagulation is the (specific) conversion of a plasma protein fraction (fibrinogen) from the state of a colloidal hydrosol to that of the corresponding quasicrystalline (oriented micelle) gel (fibrin), and that this is the second of a two-phase process, the first being the elaboration of an essential agent (thrombin) from an inactive, probably protein, pre-

cursor (prothrombin), now known to be also a plasma-, rather than a cell-, constituent.

It has generally been recognized that the normal maintenance of the fluidity of the circulating blood is due to the absence of active thrombin. Since the blood, even the plasma devoid of all formed elements, can be shown experimentally to be a source of all the known factors (prothrombin, ionizable Ca, cephalin, etc.) required for thrombin formation, the problem has been why the necessary reactions do not normally occur in fluid blood.

Morawitz's name is particularly connected with the theory of lack of specific "activators" (of prothrombin), and his term "thrombokinase" and the almost identical term "thromboplastin" (Howell) have continued as working names ("shop numbers," if you will) for their designation. Bordet added some new facts and a nomenclature which only complicated the issues. Howell (Wooldridge, Zak and Bordet said "lecithin") identified the phospholipid *cephalin* as a chemical component of "thromboplastin," but, significantly, went on to develop the rival theory, *viz.*, that the failure of thrombin formation was due to specific "inhibitors." An important outcome of this work (with his pupils McLean and Holt) was Howell's second chemical discovery, "heparin," together with firm foundations for the more recent researches as to its mode of action. The simplicity of the Howell theory has had wide appeal, but "coagulationists" have raised many experimental objections. The first is a definite suspicion that the heparin demonstrable in blood is an artefact of the mode of separation or demonstration. A second is that no satisfactory explanation is forthcoming of the mode of removal of the heparin-type inhibitors in clotting blood. Howell, himself, is forced back to a theory of "neutralization" by "thromboplastin." So, in a roundabout way, both theories come back to this ill-defined agent which is undoubtedly not merely a cephalin-protein compound.

Alex. Schmidt, the father of the "thrombin theory," proceeded from the assumption that blood coagulation (like that of milk) was essentially a protein-enzyme reaction. Nolf and others contributed much to an enzyme view which was fraught with the fallacy that thrombin is, itself, a proteolytic enzyme. We believe this to be fallacious because the purest and most potent thrombins are quite (or almost) free from the ability to produce fibrinolysis and more complete proteolysis (*e.g.*, positive biuret and ninhydrin tests, increase in –COOH (formol titration) or in amino-N). Trypsin will digest, but will not clot, prothrombin-free fibrinogen. One proteolytic enzyme, papain, will do both.

A vast amount of work, with very little direct bearing on blood coagulation, had as its starting-point the "Abderhalden reaction," *i.e.*, the alleged appearance in blood serum of proteolytic enzymes, specific for parenterally injected ("foreign") proteins. The positive evidence for such phenomena has continued to pile up, despite the well-founded objections of biochemists and immunologists. At the same time, the valid objection, that non-specific proteases can be demonstrated in tissue- and blood-cells and in serum, is equally factual. Oppenheimer points out that the serum enzymes are chiefly "tryptases" and "peptidases." A. Schmitz gave clear indication of a complex plasma system composed of (1) inactive precursor or zymogen (for which we should like to suggest the term "tryptogen," in analogy with pancreatic trypsinogens); (2) specific antitryptase; (3) kinase (activator) required for the tryptase to be liberated in active form. The analogy to the pancreatic trypsin system (ref. Northrop) is complete.

As far back as 1913, Collingwood and MacMahon produced thrombinolysis and hence inhibition of coagulation of blood by trypsin and suggested possibilities for the theory of clotting. Eagle (1937) reviewed subsequent work on trypsin in relation to blood coagulation. When Northrop and Kunitz showed their crystalline trypsin to be a coagulant, and Eagle, followed by the author, both using the crystalline enzyme, confirmed earlier work showing that the mode of action was "thromboplastic," the way was opened for reinvestigation of the old data on blood enzymes. It had long been known that blood serum is able to inhibit preparations of pancreatic trypsin. Northrop's crystalline trypsin-inhibitor (from pancreas) prevented trypsin from clotting $MgSO_4$-plasma. The author, in some unpublished experiments[1] with a similar inhibitor preparation (supplied through the courtesy of Dr. T. E. Weichselbaum, of Washington University, St. Louis), finds evidence of inhibition of ordinary clotting (!) of recalcified plasma by the crystalline inhibitor. The data indicate anti-fibrinolytic as well as anti-prothrombic and anti-thrombic effects. A cofactor is necessary, at least for the last, and can be supplied in crude plasma albumin. These actions closely resemble *heparin,* but are much weaker. Can it be that the pure polypeptide has a "heparin-like" acid-prosthetic group? Heparin is anti-tryptic.[2]

Ferguson believes that the natural blood tryptase (when freed from inhibitor and "activated") is the "missing-link" in the "thromboplastic" activation of prothrombin to thrombin. If present in sufficient amount and under adequate conditions, this tryptase can also *digest:* (1) prothrombin and thrombin (hence constituting "progressive" antithrombin);

[1] Ferguson, *Proc. Soc. Exp. Biol. and Med.*, 1942 (in press).

[2] Horwitt, SCIENCE, 92: 89, 1940; Glazko and Ferguson, *Proc. Soc. Exp. Biol. and Med.*, 45: 43, 1940.

(2) fibrinogen and fibrin[3] (hence the term "fibrinolysin" is superfluous); (3) non-specific substrates such as casein (in which small increases in formol-titration and N.P.N. have been occasionally observed). There can be little doubt that "active" tryptase is not normally present in the blood but requires "damaging" or disturbing procedures such as trichloracetic acid precipitation, shaking with chloroform (long known as an "antitrypsin" neutralizer), dialysis, etc. Still to be explained are the exact mechanisms of such "damage" in shed blood, but the fact that profound disturbances in colloidal equilibria do accompany "wetting" (contact with foreign surfaces) and the whole set of conditions encountered *in vitro* can not be denied. Autolysis of damaged tissue cells is an analogy, and the ease of trypsinogen activation is confirmed by Northrop's experiments with the crystalline substance. That "tryptogen" activation proceeds *autocatalytically* is suggested by some recent experiments[4] relating tryptase liberation to actual clotting.

The wide applicability of the new theory is indicated by the following chosen illustrations:

(1) Hemophilic[5] plasma (*in vitro*) is readily clotted by trypsin (and crude tissue "thromboplastins") when cephalin, alone, is of little avail.

(2) Danger of intravascular coagulation at present offers an insuperable obstacle to intravenous use of trypsin as a hemostatic, but ways of overcoming this serious obstacle may possibly be found.

(3) Serum-tryptase accounts for the instability and spoilage of plasma and plasma protein preparations. At present these difficulties are being overcome, very satisfactorily, but empirically, in the war production of plasma substitutes and hemostatic agents.

(4) Many anomalies in the experimental literature on blood-clotting find a ready explanation in the light of the various actions of trypsin.

(5) Close links are forged between blood-coagulation and immunological fields, and the two fields merge in the consideration of "transfusion reactions" and anaphylactic shock.[6]

In summary, the new clotting theory revolves around the proteases of the blood (plasma and formed elements) and tissue cells. Normally, the enzyme is not in the active state. "Damage," *i.e.*, colloidal disturbance, introduces new conditions favorable to activation of the enzyme. Tryptase, optimally in conjunction with ionized calcium and free phospholipid (cephalin), acts as a "thromboplastic" agent for the conversion of prothrombin to thrombin.[7] Thrombin is enzyme-like in potency and in the kinetics of its interaction with fibrinogen to form fibrin. Proteolytic phenomena such as fibrinolysis and a trace of ordinary protein cleavage are variable and due, not to thrombin, but to continuing action of serum protease. We can leave to the immunologists the problems of "foreign" protein cleavage but suggest that they look for quantitative changes in normal protease-inhibitors.[6]

In this theory, the important natural anticoagulants are tryptase-inhibitors. They seem to be present in normal plasma (and serum) and may be polypeptides with acidic (heparin or heparin-like) prosthetic groups. We do not wish to go so far as to assert that they must have the chemistry of heparins (mucoitinpolysulfuric-esters, Jorpes *et al.*). Our erstwhile colleague, Dr. A. J. Glazko, now on active service with the U. S. Navy, clearly showed that heparin is "specific" only in a physico-chemical sense. Analogous inhibitions may be produced with many agents, *e.g.*, polyvalent anions, sulfonic dyes and certain lipids (Jobling and Peterson; Chargaff), also the *basic* protamines (Ferguson, *et al.*). The antithromboplastic, anti-prothrombic and anti-thrombic actions of these inhibitor mechanisms form three defense lines against the untoward possibility of coagulation *in vivo*.

Our hypothesis combines the Morawitz and Howell and Nolf view-points by bringing all three into line

[3] Timing of fibrinolysis with the aid of the Evelyn photoelectric colorimeter is recommended as a simple and very sensitive method for assay of active tryptase (Ferguson, *Proc. Soc. Exp. Biol. and Med.*, 1942, in press). Clot-retraction (syneresis) is merely incipient fibrinolysis (Hirose, 1934; Ferguson, 1939). Tagnon's recent fibrinolytic studies (*Jour. Lab. and Clin. Med.*, 27: 1119, 1942) afford strong support for the major premises of the Ferguson theory.

[4] Ferguson, *Jour. Lab. and Clin. Med.* (in press, 1942).

[5] Feissly (*Helvet. Med. Acta*, 8: 823, 1941) uses a gelatine liquefaction technic to confirm the suggestion of Ferguson (*Am. Jour. Physiol.*, 126: 669, 1939) that hemophilia is a plasma defect in available protease. This view is further confirmed by Tagnon, Taylor, *et al.*, *Jour. Clin. Invest.*, in press, 1942.

[6] Burdon, *Proc. Soc. Exp. Biol. and Med.*, 49: 24, 1942.

[7] The fact that we have prepared prothrombin incapable of activation by Ca alone (despite the presence of cephalin, bound to the protein, demonstrated by analysis) and that the further addition of the pure "free" phospholipid quickly and completely converts it into a stable thrombin able to produce stable fibrin clots (*i.e.*, no evidence of tryptase), causes us, tentatively, to hold on to the view that the thromboplastic role of tryptase consists in catalyzing the formation of a prothrombin + calcium + cephalin "intermediary" complex in thrombin formation. The "final" thrombin can be obtained completely free from Ca and P-lipid. The proved ability of tryptase to activate prothrombin in oxalated or citrated materials (in which Ca-ions, as well as Cephalin, are "bound") is somewhat difficult to fit in with our (1936–1939) "cephalin availability" theory and the answer must be found in the future preparation of a purified prothrombin, completely freed from all, even bound, calcium, phospholipid and serum-tryptase. It is to be regretted that several recent attempts at prothrombin purification have been so concerned with the question of potency as to give scant attention to the equally significant problem of getting rid of these known chemical impurities, to which important characteristics of the allegedly "pure" preparations may very well be due.

with the newer knowledge of tryptase enzymes and their inhibitors. The subject is necessarily complex in view of the difficult and imperfectly understood chemistry. Nevertheless, we believe our solution to be a logical one and sufficiently in accord with a wide knowledge of experimental fact to satisfy the requirements of a "working hypothesis." Such is valuable in the assessment of current progress, in planning experiments for the future, and, above all, in its clear applications to immediate practical aims.

OBITUARY

DR. SUSAN P. NICHOLS, 1873–1942

DR. SUSAN P. NICHOLS, emeritus professor of botany of Oberlin College, was born at Brownville, Maine, on May 12, 1873, and died at her home in Portland, Maine, on December 7, 1942. She was graduated from the Brunswick High School and Bradford Academy, and from Cornell University with the degree of B.S. in the class of 1898, remaining at Cornell as a fellow, 1898–99. During the following year she occupied the American Woman's Table at the Naples Zoological Station. After teaching science at Houghton Seminary, New York, she studied at the University of Wisconsin, receiving her Ph.D. in 1904, with a thesis on Binucleate Cells in Basidiomycetes.

Following two years of teaching in a private school in Kentucky, she came to Oberlin as an instructor in botany in 1908 and remained at that institution until the end of her teaching career. In 1925 she was made professor, and on the retirement of Professor Frederick O. Grover, succeeded him as head of the department. This position she held until her own retirement in 1938. Her membership in scientific organizations included the American Association for the Advancement of Science, American Society of Naturalists, Botanical Society of America, Ohio Academy of Science and the Josselyn Botanical Society of Maine.

Her published work, other than the thesis mentioned, has to do with the physiology of algal cells, but her final illness interrupted work on native orchids in which she had been engaged for some time. This brief record does insufficient justice to her services for science. Her influence on students was notable. Despite the handicap of a withered arm, she was a skilled technician who aroused in her students an enthusiasm for clean and careful technique. She was blessed with a forthright and lucid New England mind which could give direction and perspective to this skill. The impact of her rugged honesty on the minds of her students was powerful and salutary. This honesty, with her common sense and force of character, also won for her a position of influence in the councils of the democratically governed college on whose faculty she served for thirty years. PAUL B. SEARS

DEATHS AND MEMORIALS

DR. LEONHARD STEJNEGER, head curator in biology at the U. S. National Museum, died on February 28 in his ninety-second year.

DR. LILLIEN JANE MARTIN, professor emeritus of psychology at Stanford University, died on March 26 at the age of ninety-one years.

DR. WILLIAM EDGAR CALDWELL, professor of clinical obstetrics and gynecology at the College of Physicians and Surgeons, Columbia University, and associate director of the Sloane Hospital of Columbia University, died on April 1. He was sixty-three years old.

JOHN A. NEWLIN, who retired from the staff of the U. S. Forest Products Laboratory at Madison, Wis., on March 1, died on March 27 at the age of seventy-one years. He had been with the Forest Service since 1904.

PALEMON HOWARD DORSETT, agricultural explorer, recipient of the Meyer Medal for distinguished service, for forty-one years horticulturist with the U. S. Department of Agriculture, died in Washington, D. C., on April 1 at the age of eighty-one years.

MAJOR LEONARD DARWIN, fourth and last surviving son of Charles Darwin, died on March 21 at the age of ninety-three years.

PROFESSOR ANTONIO CARDOSO FONTE, Rio de Janeiro, Brazil, formerly director of the Instituto Oswaldo Cruz in Rio de Janeiro, known for his work on tropical diseases, died on March 27 at the age of sixty-three years.

A RESOLUTION to declare February 11, 1944, Thomas Alva Edison Day in memory of the inventor, was approved on March 29 by the Judiciary Committee of the U. S. Senate.

A MONUMENT to the memory of William H. Jackson, pioneer artist and photographer of the early West, was dedicated on Sunday, April 4, at Arlington National Cemetery by the Explorers' Club of America and the American Pioneer Trails Association. The occasion was the one hundredth birthday of Mr. Jackson, who died last year at the age of ninety-nine years. Mr. Jackson made the first photographic record of "Old Faithful" in Yellowstone National Park. He later served as official photographer with the U. S. Geological Survey.

SCIENTIFIC EVENTS

THE NEW YORK BOTANICAL GARDEN

AT the recent annual meeting of the Board of Managers and the Corporation of the New York Botanical Garden, Dr. William J. Robbins, director of the garden, described how the war effort had been aided not only through the men from the staff who have gone into war service, but also by the furnishing of information to government agencies and to individuals concerned with effects of the war. It was made clear that it is because of the program carried on through years of peace in training men and accumulating botanical information and collections that the garden is able to respond effectively to war demands.

Dr. Robbins stated that despite the exigencies of the war situation, an effort was being made to keep the garden running on as nearly a normal scale as possible, particularly in the way of displays for the enjoyment of the public, in the pursuit of scientific work and in instruction. Because of the importance of the home culture of vegetables at this time, the garden has expanded its program in gardening education and has put on several new courses in vegetable gardening, two of which, given in cooperation with *The New York Times*, attracted audiences of 500 persons each.

In describing specific war services, Dr. Robbins said that the Office of Strategic Information had been furnished with photographs and special maps of areas in which the staff of the garden had collected plants in years past. Leaves of tropical trees for studies on camouflage have been furnished. Crude drugs, collected by the late Dr. H. H. Rusby more than forty years ago and preserved in the collections, have been supplied for chemical study. Six months from now new supplies can be obtained from South America. The only available supply of these materials at the moment is in the museum cases of the garden. Plants have been identified, information and other services pertaining to the war have been furnished to the Navy, the War Department, the Office of the Censor, to magazines, commercial firms and individuals.

In addition to the men who have joined the Army, Navy or Air Force, several in addition to former students have left for tropical regions, where they will be engaged at least for the duration of war in the study and production of critical plant products, such as rubber, quinine, sisal and many others.

Horticultural achievements of the past year include the planting of the Pelham Parkway entrance with 332 trees, the planting of 600 rhododendrons in their permanent places near the present rhododendron glade and the preparation for additional future plantings by making 29,000 cuttings of woody plants, lining out 15,000 other cuttings and setting 4,000 young plants out in the nursery.

Definite future plans include a new rose garden in the vicinity of the Main Conservatories, an addition to the greenhouse to provide for more extensive flower displays, new landscaping, a rearrangement of roadways and the construction of a restaurant and comfort station on the grounds.

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

A SPECIAL committee appointed by President L. M. Hutchins opened and canvassed the official 1942 ballots of the American Phytopathological Society. As a result of this election, Dr. J. C. Walker, department of plant pathology of the University of Wisconsin, was elected president for 1943. Dr. J. J. Christensen, of the department of plant pathology of the University of Minnesota, was elected vice-president, and Dr. J. G. Leach, of the department of plant pathology and bacteriology of the University of West Virginia, was elected councilor for two years. The old and new officers and members of the council met at Columbus on February 12 and 13 to conduct necessary business. At the same time the War Committee of the society met and passed the following resolutions:

1. That in view of vital needs for increased food, feed, fiber and oil production—plant pathologists of the United States immediately undertake to get the 1943 recommendations for control of diseases of all war goal crops into active use, employing all available channels to that end.
2. The declaration of a nation-wide seed treatment campaign for the reduction of plant disease losses of the essential crops in the war production program with special emphasis on oats, barley, wheat, sorghum, flax, corn, cotton, peanuts and certain vegetable crops as a means of insuring against poor stands and as a means of stretching limited seed supplies.
3. That efforts be made to include established plant disease control recommendations into the action programs for achieving war crop goals.
4. That to prevent waste of vegetable seeds the War Committee of the American Phytopathological Society recommends that Victory gardeners protect their seed from decay and improve stands of plants by treating seeds with disinfectants known as Semesan or Spergon or in accordance with recommendations of their State Agricultural Extension Services and Experiment Stations.
5. That plant pathologists in each state be urged to make every effort to obtain information on the development of major disease hazards throughout the season with the aid of such other agencies and individuals as may be available, with a view to the issuance of timely warnings to growers and recommendations of immediate measures to be taken to check epidemics or to lessen losses that would otherwise result.

6. That the Seed Treatment Committee of the society be asked to prepare 1943 recommendations for the seed treatment of wheat, oats, barley, sorghum, flax and corn for distribution to all States.

7. That the Seed Treatment Committee be encouraged to work with seed producers and seedsmen with a view toward getting more seeds treated prior to distribution and sale, and/or getting directions for treatment printed on packages or packets and in seed catalogues.

8. That the Vegetable Seed Treatment Sub-committee of the society be asked to prepare seed treatment recommendations for Victory gardeners and for commercial vegetable growers and distribute to all States through the War Committee.

9. That the Seed Certification Committee's efforts to obtain the treatment of certified seed be endorsed.

10. That the Fungicide Committee of the War Committee be asked to distribute promptly a condensed statement of their present opinions as to measures for conserving fungicides.

THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

THE twenty-ninth annual meeting of the American Association of Cereal Chemists will be held at the Hotel Jefferson, St. Louis, from May 17 to 19. Five different phases of cereal technology will be under discussion, these being divided into the following subjects: Industrial Utilization of Cereals; Agronomy and Milling Technology; Brewing and Malting Technology; Baking Laboratory Methods and Baking Technology; The Firing Line with Cereals. The last subject will occupy the whole day on May 19.

Ex-Governor Herbert H. Lehman of New York, director of foreign relief and rehabilitation operations at Washington, will make an address on the opening day on "The Problems of Feeding Starved Nations."

Thirty-eight papers are scheduled for the program, the industrial utilization of cereals being emphasized throughout, thus giving to it a highly practical aspect. Among the topics to be discussed are The Bacterial Fermentation of Cereal Carbohydrates; The Distillation Industry in War and Peace; Industrial Utilization of Corn Proteins; Oil Products from Cereal Grains; Industrial Uses of Wheat Proteins; The Grading and Storage of Grains; Entomology and Insection Control of Grains; Practical Technical Applications and Control in Bread Baking; Macaroni and Noodle Manufacture, as well as in Cracker and Cookie Manufacture and Cake Baking, and the Application of Cereals in the Malt Industry. These general topics show the industrial character of the program. Other subjects of equal value in the chemistry of cereals and cereal technology will be presented

A general invitation is extended to all who may be interested in attending the meetings to take part in the general discussion of the papers, for which an ample time allowance has been made.

GUGGENHEIM FELLOWSHIPS, 1943

BELIEVING that the continuous fostering of research and creative work is necessary for the development of the values that make civilization, for the sake of which the United States is at war, the John Simon Guggenheim Memorial Foundation in its annual awards of fellowships has announced the addition of sixty-four fellows to its lists. However, it is recognized that no institution can or ought to try to escape the great urgencies of these times, and accordingly all fellows have been informed that the use of their fellowships is subject to any war work or military or naval duties to which they may be called; but should any recipient of a fellowship be called into service his fellowship will be held for him until the war has been won. The number of fellowships awarded this year is considerably less than the number awarded in recent previous years and the foundation is reserving a part of its funds for fellowships for those now in the war effort who doubtless, but for that circumstance, would have applied for and have been granted fellowships this year.

The theme which underlies the diversified list of fellowships granted this year is the theme of understanding the civilization in which we live and particularly the understanding of the Americas. A group of awards is in the field of philosophy, and these fellows are planning to work in the field of moral philosophy, attempting to gain understanding of the principles by which ethical judgments or judgments of human values are formed.

This is the eighteenth annual series of awards by the foundation, which was established and endowed by the late United States Senator Simon Guggenheim and by Mrs. Guggenheim as a memorial to their son John. The Guggenheim fellowships are granted to scientific workers, scholars, artists and creative workers in all fields who by their previous work have shown themselves possessed of unusual ability, demonstrated by the previous production of contributions to knowledge or by the production of works of art. Men and women, married and unmarried, of all races and creeds who are citizens or permanent residents of the United States, citizens of Canada and of certain Latin American countries are eligible on equal terms. The fellows are normally of ages between 25 and 40 years. The stipends are usually $2,500 a year. Since its establishment eighteen years ago, the foundation has granted 1,289 fellowships with stipends amounting to $2,662,000.

The fellowships now announced are granted to American and Canadian scholars and creative workers and are accompanied by stipends amounting to $140,000. A series of fellowships for Latin Americans will be granted in June. The list of fellowships now announced contains the names of eleven women. There

are no appointments in fields of the physical and mathematical sciences because all first-rate workers in these fields are needed for direct war work or for teaching to insure continuity in the supply of scholars in these fields. The list includes one Filipino poet, one Negro economist and one Chinese artist. Several of the fellows will work in Latin America and several in Canada, while the Canadian fellows will work in the United States. Fellowships awarded in the sciences are:

WILLIAM VOGT, associate director of the Division of Science and Education, Office of the Coordinator of Inter-American Affairs: Preparation of a book on Peru's guano birds, based on three years of study on the West Coast of South America, from Cabo Blanco to the Strait of Magellan, carried on when he was naturalist to the Peruvian Guano Administration.

DR. KENNETH EDWARD CASTER, assistant professor of geology in the University of Cincinnati: A field study of the Paleozoic strata of the Northern Andes in Colombia and adjacent Venezuela.

DR. EDGAR ANDERSON, professor of botany, Washington University, and geneticist, Missouri Botanical Garden, St. Louis: The genetics of Indian corn, in Mexico and the Southwestern United States.

DR. FLOYD ALONZO MCCLURE, on leave from his post as professor of economic botany, Lingnan University, Canton, China: A book on the Chinese bamboos.

DR. HENRY PAUL HANSEN, assistant professor of botany, Oregon State College: A study of Post-Pleistocene forest succession and climate in the Pacific Northwest, based on fossil pollen analyses of peat deposits and other types of lake sediments.

DR. E. LUCY BRAUN, associate professor of plant ecology, University of Cincinnati: Studies of the ecology and taxonomy of the deciduous forest.

DR. TILLY EDINGER, research associate in paleontology at the Museum of Comparative Zoology, Harvard University: A paleontological study of the tooth development in amphibians and reptiles, particularly primitive fossil types, with special reference to the history of dental succession in the evolutionary line leading from ancestral fishes to mammals.

JOHN FRANCIS HANSON, teaching fellow in entomology, Massachusetts State College, Amherst: A study of all genera and species of stoneflies in the United States.

DR. BARBARA S. BURKS, research associate in psychology, Columbia University: To gather materials for a book on the role of twins in the study of man, based on case studies of the development, life adjustment in maturity and environmental history of identical twins separated in infancy and reared apart.

DR. SOLOMON E. ASCH, assistant professor of psychology, Brooklyn College: To prepare a book on the formation and change of opinion and attitude, based upon experimental investigations.

The trustees of the foundation, in addition to Mrs. Guggenheim, are Francis H. Brownell, Carroll A. Wilson, Charles D. Hilles, Roger W. Straus, Charles Earl, John C. Emison, Medley G. B. Whelpley and Charles Merz.

The committee of selection consisted of Dr. Frank Aydelotte, director of the Institute for Advanced Study, *Chairman;* Dr. Florence R. Sabin, of the Rockefeller Institute for Medical Research; Professor Edwin Bidwell Wilson, of the Harvard University School of Public Health; Professor Linus Pauling, of the California Institute of Technology, and Professor Wallace Notestein, of Yale University.

The fellows chosen this year come from fifteen states and the Philippines and from two Canadian provinces. Forty-four fellows are members of the staffs of thirty educational institutions, while twenty are free-lance workers.

VISIT OF LATIN-AMERICAN ENGINEERS TO THE UNITED STATES

EIGHTEEN Latin-American engineers, representatives of fourteen countries, who are visiting Greater Boston, arrived on April 5 at Harvard University, one of the twenty-five universities and electrical establishments they plan to inspect during a year's visit to the United States. They are particularly interested in rural-electrification problems.

Dr. Francisco Castillo Najera, Mexican Ambassador to the United States, and Dr. Gonzalo Bautista, Governor of the State of Puebla, are leaders of the Mexican party. From April 5 to April 9 they were entertained by state and city officials, scientific societies and institutions and private individuals. Harvard Observatory arranged the program of entertainment in token of its interest in the new national astrophysical observatory at Tonantzintla, near Puebla. Dr. Luis Enrique Erro, director of the observatory; Señor Salvador Duhart M, first secretary of the Mexican Embassy; Dr. Carlos Graef, assistant director of the observatory, and Dr. Frederico Jiminez O'Farrill were among the visitors.

On Tuesday morning Major General Sherman Miles, commander of the First Service Command, called on the deputation at the Copley Plaza Hotel. During the morning the deputation visited Governor Saltonstall, President Conant, of Harvard University, and Mayor Tobin. The Mayor gave a luncheon in honor of the party and Governor Saltonstall was host at a tea in his home in the afternoon. Jerome Greene, secretary of the Harvard Corporation, was host at a dinner in the Tavern Club in the evening, after which a special meeting of the American Academy of Arts and Sciences was convened in tribute to the sponsorship by Governor Bautista of one of the most important observatories in Latin America, and in tribute to

the scientific accomplishments of the Mexican Ambassador. Dr. Harlow Shapley, director of the Harvard Observatory and president of the academy, presided. Ambassador Najera spoke on cultural relations between the United States and Mexico, and Dr. Kirtley F. Mather, professor of geology, discussed the earthquakes, volcanoes and mountain systems of Mexico. Members of the Pan-American Society of Massachusetts attended the meeting and the reception which followed.

Headquarters of the First Service Command, Harvard Observatory and the Harvard Medical School were visited on Wednesday morning. There was a reception at the Fogg Art Museum in the afternoon followed by a concert by the Harvard Glee Club and a tea given by the Harvard Corporation. Dr. Godfrey Cabot and Mr. and Mrs. Ralph Bradley gave a formal dinner in the evening. A visit to the Massachusetts Institute of Technology on Thursday morning preceded an inspection tour of Fort Devens, and was followed in the afternoon by a visit to the Harvard Oak Ridge Observatory and the Seismographic Station. After various private social functions the party attended a reception at Radio Station WRUL on Thursday evening at which the Governor and the Ambassador were interviewed for a shortwave broadcast in Spanish.

The official group leaves Boston on April 9 for Springfield, where it will be entertained before its departure for New York City. Dr. Bart J. Bok, of the Harvard Observatory, was in general charge of the arrangements.

SCIENTIFIC NOTES AND NEWS

THE New York Section of the American Chemical Society has awarded the Eli Lilly and Company Prize of $1,000 in biological chemistry for 1943 to Dr. Herbert E. Carter, of the University of Illinois.

DR. WILBUR A. SAWYER, of the International Health Division of the Rockefeller Foundation, was the guest of honor at an official reception held on March 26 by the City Council of Guayaquil, Ecuador. After the reception he laid the cornerstone for a statue of John D. Rockefeller being erected to mark Ecuador's gratitude for the eradication of yellow fever in 1919.

THE Herbert Jackson Prize for 1942 of the London Midland and Scottish Railway has been awarded to J. Dearden, of the Metallurgical Section of the Railway's Research Department, for papers entitled "The Inspection of Welded Steel Joints in Relation to Their Static Mechanical Strength," and "The Influence of Welding Defects on the Resistance to Fatigue of Welded Steel Joints."

DR. ROBERT A. BROTEMARKLE, professor of psychology and personnel officer of the college at the University of Pennsylvania, has been appointed director of the psychological laboratory and clinic and chairman of the department of psychology to succeed the late Dr. Edwin B. Twitmyer. Dr. Brotemarkle has resigned as personnel officer, a position which he has held in conjunction with his teaching activities since 1926. He has been connected with the department of psychology since 1919.

DR. PAUL F. BARTUNEK, instructor in physics at Rensselaer Polytechnic Institute, has been appointed assistant professor of physics at Allegheny College.

DR. WALDO L. SCHMITT, who has been engaged continuously in biological research under the Government since 1907 and as curator of marine invertebrates in the U. S. National Museum since 1920, has been selected to fill the position of head curator of biology made vacant by the death on February 28 of Dr. Leonhard Stejneger. Dr. Schmitt will assume his new work on his return from his trip to South America. Dr. Doris M. Cochran, since 1919 a member of the staff of the National Museum, since 1927 as assistant curator of reptiles and amphibians, has been named associate curator in charge of that division.

DR. LEWIS HILL WEED, professor of anatomy and director of the School of Medicine of the Johns Hopkins University, has been made chairman of the Medical and Health Advisory Committee of the American Red Cross.

H. H. ALP, associate professor of poultry extension at the University of Illinois, will serve during the emergency as senior poultry specialist with the Institute of Inter-American Affairs. It is expected that his headquarters will be at Rio de Janeiro, Brazil.

DR. RALPH H. MANLEY, formerly principal chemist and chief of the oil and protein division of the Northern Regional Research Laboratory, U. S. Department of Agriculture, has joined the research staff of General Mills, Inc. He will study the development of new industrial uses for vegetable oils and proteins and their derivatives.

JEROME SWIMMER, of Baltimore, has been appointed assistant toxicologist in the Medical Research Division of the Chemical Warfare Service at Edgewood Arsenal, Maryland.

DR. JAMES M. SPRAGUE has been appointed director of organic chemical research in the Medical Research Division of Sharp and Dohme, at Glenolden, Pa.

Since 1937 he has shared in the direction of organic research work in the organization. Under the new arrangement he will direct the program of these laboratories in the synthetic organic field.

F. W. NITARDY, vice-president of E. R. Squibb and Sons, has been elected vice-president and technical director of its newly formed subsidiary, E. R. Squibb and Sons Inter-American Corporation.

DR. MELVILLE SAHYUN, formerly director of biochemical research, has been appointed director of research for Frederick Stearns and Company of Detroit, Mich.

DR. JACK W. DUNLAP, who has leave of absence from the University of Rochester, has resigned as director of research of the Committee on Selection and Training of Aircraft Pilots of the National Research Council and has accepted a commission as Lieutenant Commander in the Navy. He is attached to the Aviation Psychology Section of the Bureau of Medicine and Surgery and is working on problems of selection of aviation personnel.

FELIX WEBSTER MCBRYDE, instructor in geography in the Ohio State University, has been appointed senior geographer in charge of the Latin American Field of the Military Intelligence Service, War Department, Washington, D. C.

DR. FLOYD S. MARKHAM, associate professor of bacteriology at the Ohio State University, has leave of absence. He has left Columbus for North Africa to take charge of laboratories for the Typhus Commission of the Rockefeller Foundation.

ABBE HENRI BREUIL, formerly professor of prehistoric ethnology at the Collège de France and director of exploration at the Institute of Prehistory, has gone to the Union of South Africa to conduct researches on the Rand for the duration of the war.

THE Jayne Memorial Lecture of the American Philosophical Society was delivered on March 31 by Dr. Detlev W. Bronk, Johnson professor of biophysics and director of the Johnson Foundation at the University of Pennsylvania. His subject was "Physical Machines and Physiological Mechanisms in Aviation."

DR. LOWELL T. COGGESHALL, of the School of Public Health of the University of Michigan, will deliver the Cutter Lecture on Preventive Medicine at the Harvard Medical School on April 27. His subject will be "The Importance of Tropical Diseases in the Current and Post-war Period."

PROFESSOR GUY-HAROLD SMITH, chairman of the department of geography of the Ohio State University, gave a series of lectures at the College of Commerce of the State University of Iowa on March 23 and 24. He spoke on "The Geographical Basis of Pan-Americanism," "Japan's Position in the Southwest Pacific," "Geopolitics, a New Design for the World" and "Cartography and the War."

MEDAL DAY of the Franklin Institute, Philadelphia, will be held on April 21. The date was incorrectly given in SCIENCE last week.

BY action of the Board of Trustees of the University of Illinois, the departments of zoology and physiology will be merged. Professor Carl G. Hartman, who has served as head of both departments for the past two years, will continue as head of the new department of zoology and physiology.

THE Rockefeller Foundation has for the third year in succession made a grant to the Royal Society, London, to enable it to give assistance to scientific societies and associations which, as a result of war conditions, are experiencing financial difficulties in the publication of scientific journals.

THE residue of the estate of Major Henry Reed Hatfield, Philadelphia, valued at $1,000,000, has been bequeathed, after the payment of $226,000 in specific bequests to charities, to the University of Pennsylvania and to Jefferson Medical College.

AN agreement has been concluded between the New York Botanical Garden and the American Society of Plant Taxonomists whereby *Brittonia,* a journal of plant taxonomy published by the garden, becomes an official organ of the society. Members of the society subscribe to *Brittonia* at a special rate and are accorded all privileges of publication in it. An editorial board has been appointed consisting of H. W. Rickett (for the New York Botanical Garden), Earl E. Sherff, C. A. Weatherby and S. F. Blake. *Brittonia* will be published, as heretofore, at irregular intervals; the first issue under the new arrangement is expected late this year.

THE University of Leeds has received a gift of £50,000 from Henry Ellison, to establish an endowment fund for the provision of post-graduate fellowships for research in pure and applied chemistry and in physics.

AN endowment by the late Frank Collins, of the National Supply Company, has made possible the erection of a new two-story building 136 × 95 feet to house the Toledo Hospital Institute of Medical Research. The institute consists of a staff including a biochemist, a nutritionist, a bacteriologist, a pathologist and a biophotographer under the direction of Dr. Bernhard Steinberg. The staff will be augmented in the future by a physiologist, a biophysicist and a pharmacologist. Provision has been made to accept fellows in medical and dental research. It is the pur-

pose of the institute not to devote itself exclusively to the study of a single disease, but to maintain a fluid interest in disease in general depending upon the availability of the specific personnel.

THE late Dr. Robert Boyd, formerly chairman of the Manchester Division of the British Medical Association, made a bequest to the association for the benefit of his professional colleagues in the Manchester area. The gross value of his estate is in the region of £100,000. Subject to certain life interests, the residue is left to the British Medical Association to be applied to capital as well as income for the purpose of endowing or contributing to the endowment of a British Medical Association House in the district of Manchester for the benefit and use of all qualified and registered doctors. The power of making regulations for the conduct and use of the house are vested in the Governing Committee for the time being of the Manchester Division of the association.

The Lancet states that the Rockefeller Foundation has given £1,200 to the University of Oxford for biochemical investigations of penicillin under the direction of Dr. H. W. Florey, professor of pathology. The foundation has made a further grant of £3,500 towards the initial equipment of the nutritional survey.

THE Langley Porter Clinic of the Medical School of the University of California, San Francisco, was opened on February 13. The outpatient department was named in honor of the late Dr. Aaron J. Rosanoff, who was largely responsible for the building of the clinic. At the time of his death he was director of the California State Department of Institutions.

ACCORDING to *Museum News*, the California Academy of Sciences, San Francisco, includes in its future plans the erection of a new wing to the African Hall and an Alice Eastwood Herbarium to house the more than 300,000 specimens collected by her during a long career as curator of the department of botany.

To meet the growing importance of physics in industrial research, the central chemical laboratories of the Hercules Powder Company, as announced by Dr. Emil Ott, director of research, has formed a separate technical group to coordinate and develop physics work. Research by the new group at the Experiment Station, of which Dr. Robert W. Cairns is director, will emphasize electrons and optics, using such equipment as the electron microscope, mass spectrograph, x-ray diffraction cameras for crystal structure analysis and spectrographs for a complete range of light-absorption studies not limited to the visible spectrum but ranging from ultraviolet to infra-red. Dr. Willard P. Connor, Jr., formerly research associate at Princeton University, will be acting leader of the physics group.

THE *Bulletin* of the Institute of International Education writes: "The announcement was made by the Department of State on December 29, 1942, that awards of official scholarships, fellowships and travel or maintenance grants to United States students for study in the other American republics from Department of State funds were being suspended for the duration of the war. The suspension does not affect grants made before that date. In his announcement the Secretary of State emphasized that the United States Government had no thought of discontinuing the award of fellowships and travel and maintenance grants to citizens of the other American republics for study in the United States. On the contrary, he expressed the hope that the situation in other American countries would permit the continuance of the program for their students to come here under the Convention for the Promotion of Inter-American Cultural Relations. The announcement referred in every case to United States 'students' assisted by the Department of State and made no mention of any change in the procedure in regard to teachers or professors."

IT is reported in *Nature* that the People's Commissar for Education in the U.S.S.R. has instituted fifteen valuable Newton scholarships for Soviet university students. They are to be awarded to young men and women specializing in physics, mathematics, mechanics and astronomy. The Universities of Leningrad and Moscow will receive three scholarships each. Other Newton celebrations include exhibitions of portraits and books on Newton in English, Russian and other languages at the University of Moscow and the Scientists' Club.

THE latest information regarding the issue of new and revised British Standards, of which there are at present over a thousand, can be obtained from the library of the British Standards Institution, 28, Victoria Street, Westminster, London.

DISCUSSION

CAMEL, HORSE AND BISON ASSOCIATED WITH HUMAN BURIALS AND ARTIFACTS NEAR FRESNO, CALIFORNIA

BONES of *Camelops, Equus* and *Bison* have been found in association suggesting contemporaneity with Indian burials and artifacts on the open plain of the central San Joaquin Valley near Tranquillity, Fresno County, Calif.[1] The site lies in an old alluvial soil, fourteen miles east of the Diablo Range foothills, and

about thirty miles west of the Sierra Nevada foothills. Conditions at the site strongly suggest that the carcasses of the now extinct mammals were brought there by hunters of the group which built fires, buried its dead and made the numerous stone and bone artifacts which have been found in the deposit. The bones of the American camel, horse and bison occur along with bones of species still living in the San Joaquin Valley, broken in a manner characteristic of kitchen refuse, along with artifacts and in the vicinity of burials.

All bone on the site, whether human (four individuals were still wholly or partly articulated in a semi-flexed position), of animals, both extinct and modern, or of the numerous bone awls and other implements, is very heavily mineralized, with about twice the specific weight of ordinary dry bone and with greatly increased hardness. Out of more than 100 San Joaquin Valley archeological sites investigated by W. Massey, G. Schmidt and the writer in 1939, the Tranquillity site was the only one on which such mineralized bone occurred.[2] It was the condition of the bone which prompted further work, rather than the identification of the extinct species, which was not completed until this year (1942).

Faunal remains include two extinct species: *Camelops sp.*—mandibles, teeth, astragalus; *Equus sp.* (presumably the extinct American horse)—several teeth *Bison sp.* (not necessarily an extinct species, but unknown in the local fauna in historical times) is represented only by a tooth and orbital fragment. In addition, there was much unidentifiable fragmentary long-bone material on the site which seemed too large for any but the foregoing animals. Other forms are still surviving species: pocket gopher, badger, coyote, fox, jackrabbit, dwarf elk, antelope and salmon.[3]

Artifacts include a wide range of chert and obsidian point types, scrapers, blades and a drill; metate, mano (the latter very abundant); pestles, and mortar fragments (few); side-notched net-sinkers; grooved end stone (a possible "Charmstone"); two steatite sherds; asphaltum lumps; much burnt clay, some with stick, reed and mat impressions; bone awls, points and spatulate objects, all heavily mineralized; 56 obliquely lopped-end *Olivella* shell beads, associated with the burials, and a miscellany of broken stones of various kinds, none obtainable from the immediate neighborhood. The artifacts, while generically "Californian," are not like those of any recent archeological culture from the Central San Joaquin area, though they are similar to those from certain "early" cultural complexes described from elsewhere in the state.

In the light of finds from other parts of the continent, the occurrence of the extinct *Camelops* along with horse and bison in an archeological site is not surprising.[4] What makes the site especially interesting are the human burials, which seem to belong to the same horizon as the artifacts and extinct animals. If further work on the Tranquillity site were to establish the contemporaneity of the skeletal materials beyond question, we could determine the physical type of an early Indian population in North America for which there has been so far a great paucity of skeletal data. The writer hopes that a more detailed description of the site and its materials may be published, as there is little likelihood of further work on the site until after the war.

GORDON W. HEWES

WASHINGTON, D. C.

[1] The collections from the Tranquillity site are now in the University of California Museum of Anthropology, Berkeley.

[2] Gordon W. Hewes, *American Antiquity*, 7: 123–33, 1941.

[3] Faunal remains secured in the early work on the site were identified by Dr. Chester Stock, California Institute of Technology, Pasadena, as elk, bison, gopher, *Canis* sp., and camelid. Dr. Stock hesitated to identify generically on the basis of a single Camelid astragalus. Later and fuller collections, including mandible material, enabled Drs. Stirton, Vanderhoof, Camp and Wells, Department of Paleontology, University of California, to identify the camelid as *Camelops* sp. The later collection also included *Equus* teeth and badger bones, not present in the material sent to Dr. Stock.

[4] See the papers by F. H. H. Roberts, Jr., and Julian Steward in "Essays in Historical Anthropology of North America," *Smithsonian Institution, Miscellaneous Collections*, vol. 100, 1940.

PURE NATURAL NITROGEN GAS[1]

REFERENCE by Science Service on January 1, 1943, to an earlier account of the finding of pure nitrogen gas in a well as one of the notable discoveries of the year is misleading and the subject is perhaps worthy of brief comment. In SCIENCE of February 27, 1942, Mr. Harold J. Cook reports that 100 per cent. pure nitrogen gas was found at a depth of only 156 feet in a well drilled on the W. H. Cross ranch near the southern rim of the Powder River Basin, Wyoming. The gas is said to have developed a rock pressure of 11 pounds in 10 minutes and it is suggested that because of its purity the gas may have value in the present war emergency.

High-percentage natural nitrogen gas wells have been known for many years and are particularly common in the Permian Basin of Texas and New Mexico. Here nitrogen gas may be confined under pressures as high as 1,500 to 2,000 pounds per square inch. Analyses of some of these gases show them to contain

[1] Published by permission of the Director, Geological Survey, U. S. Department of the Interior.

from 97 to 99 per cent. of nitrogen. When a 7- or 8-inch drill penetrates a high-pressure gas pocket the gas issues with a roar that can be heard a mile or more away and the well may continue to blow for a period lasting from a day to two weeks before the pressure is sufficiently reduced to permit resumption of drilling. The initial gas flow of large wells may reach 50,000,000 cubic feet per day from a reservoir having a possible total storage capacity of one half to one billion cubic feet of nitrogen gas. Most of these nitrogen gas pockets, however, are small and many are exhausted by open flow in a day or two.

The writer has observed that large accumulations of nitrogen gas may be confined in rocks which are related to basins of saline or brackish-water deposition. The rock minerals more commonly associated with nitrogen gas in the Permian Basin are halite, anhydrite and dolomite. Pockets of nitrogen gas are most common in the Salado formation of the Permian Basin. Though they are encountered less often in drilling through the Chalk Bluff formation, which underlies the Salado, the reservoirs are usually larger and their gas pressures higher because of their lower stratigraphic position and greater depth. In the Amarillo area nitrogen gas occurs still lower in the Permian section.

Nitrogen gas accumulations indigenous to sedimentary rocks are likely to be due either to a generation of the gas by chemical reactions occurring within the sediments or by the abstraction of oxygen from air entrapped with the sediments during deposition. The question of origin of the gas involves more discussion than can be offered here. Some oxygen is reported in most of the analyses of high nitrogen gases, which suggests that the nitrogen gas of the Permian Basin may be air from which most of the oxygen has been removed.

The critical evidence to support this hypothesis is not now available. Unfortunately, the routine cryogenic analysis does not determine and report the presence of argon or the other inert gases krypton, xenon and neon. Helium is reported for special investigations only. If any of these inert gases is present it appears in the report as nitrogen. Thus no natural nitrogen gas can be considered pure unless assurance is given that no appreciable quantities of the other inert gases are present with the nitrogen. Air contains about 1 per cent. of argon and if oxygen is removed argon will make about 1¼ per cent. of the remaining gases. If the gases of the Permian Basin that contain 98 per cent. of nitrogen are found upon analysis to have about 1 per cent. of argon, the evidence will be fairly conclusive that these gases were derived from the atmosphere.

Nitrogen gas formerly considered worthless is becoming useful in industry. The atmosphere, which is about 75 per cent. nitrogen, provides a universal, inexhaustible supply of this gas for the manufacture of acids and fertilizers. Nitrogen is now employed with argon in making electric lamps. Both gases are refined separately and then used for a specific purpose in lamp manufacture. Nitrogen from gas wells could be used as a substitute for carbon dioxide to smother enclosed fires which do not require a heavy gas, for quenching fires in the fuselages and motor nacelles of airplanes and for inflating rubber boats.

WALTER B. LANG
U. S. GEOLOGICAL SURVEY

FRANZ BOAS, PSYCHOLOGIST

IN their appreciations of Franz Boas, Benedict[1] and Lowie[2,3] have discussed his professional career, beginning with his early training in physics, geography and mathematics and culminating in his pioneer contributions to physical and cultural anthropology, linguistics and ethnology. Proper emphasis, however, has not been given to the fact that toward the end of his career, Boas became increasingly interested in *psychological* problems. In fact his chief interest seems to have shifted from the anthropological description and intercomparison of cultures *per se* to the psychological description of the specific stimulating conditions under which the individual's responses are acquired. The various investigations of motor behavior carried out by his research associates, covering such studies as those on posture, walking, speed of tapping and gesture, serve to illustrate this interest in experimental social psychology. That Boas maintained an interest in this field to the end is attested by his last letter to the writer, written four weeks before his death, in which he discussed certain methodological considerations in connection with a proposed study of bodily movements accompanying speech in the American Negro.

As more and more data were accumulated, Boas became increasingly certain of his position in explaining the individual's behavior in terms of his previous stimulation and resulting reactional biography rather than in terms of such typological constructs as "race." It is in this area of the social conditioning of behavior that one appreciates Boas's interest in psychological theory, and certainly here one must disagree with Lowie[2] and find Boas more than "a faithful, intelligent collector of raw detail." Experimental social psychology has lost one of its ablest students in his death.

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[1] R. Benedict, SCIENCE, 97: 2507, 60–62, 1943.
[2] R. H. Lowie, *Scientific Monthly*, February, 1943, pp. 183–184.
[3] R. H. Lowie, SCIENCE, 97: 2513, 202–203, 1943.

QUOTATIONS

"NATURE" AND THE MACMILLAN COMPANY

THE idea of a weekly journal of science began in 1868 with discussions between Sir Norman Lockyer, the astronomer and spectroscopist, and his friends, among whom were Alexander Macmillan. Lockyer was assured of the support of T. H. Huxley, Tyndall and practically all the other leading workers in science of the time. Alexander Macmillan enlisted the support of Sir Joseph Hooker and other of his scientific friends; but much of the initial success was due to Alexander Macmillan himself, of whom Sir Norman Lockyer once wrote:

> It was in consequence of his sympathy and enthusiastic assistance that the journal started. He was unwavering in his support of the belief that British science would be advanced by a periodical devoted to its interest. . . . It was the hope that a more favorable condition for the advancement of science might be thereby secured that led Mr. Alexander Macmillan to enter warmly into the establishment of *Nature* in 1869.

In this connection we might quote part of a letter written by Alexander Macmillan to Sir William Thomson (afterwards Lord Kelvin):

> Lockyer is going to start a weekly Journal of Science, which we are to publish. It is meant to be popular in part, but also sound, and part devoted specifically to scientific men and their intercourse with each other. Huxley, Balfour Stewart, Wilkinson, Tyndall, Roscoe and almost every one who is about London have given him their names, and he very greatly wishes yours, as among those who promise support. May I tell him you consent?

The launching of *Nature* is chronicled in a letter to the Glasgow bookseller, MacLehose, written on November 3, 1869:

> *Nature* is to be published on Thursday in London at 2.30. . . . Lockyer was peremptory that our publication day should indicate the point to which our information is brought up. The fallacy of a Saturday publication with a Thursday actual information he does not think right. . . . We start with 18 pp. of advertisements. . . . I think it will look nice.

In the complete context of this letter it is worth noting that Sir Norman Lockyer had an absolutely free hand in reviewing books published by the firm of Macmillan itself, and never hesitated to criticize them adversely if he thought they deserved it. This absolute and complete freedom of policy has been extended to the editors of *Nature* from that day to this.

In 1919, Sir Richard Gregory succeeded Sir Norman Lockyer in the editorial chair of *Nature*. During his long period of editorship the journal made considerable progress, and its influence in the world of science has gradually become stronger and more secure. To-day it is the leading journal of science. In 1938, Sir Richard Gregory was succeeded jointly by A. J. V. Gale and L. J. F. Brimble. The extent to which *Nature* has now grown, not only in scientific but also sociological influence, must be left to the opinion of its readers.

One thing, however, we think that readers of *Nature* should know is the great debt which they owe to the publishers. *Nature* was initially launched and is still being published almost solely for the advancement of science, in spite of the fact that it is privately owned by a business firm. The present editors feel impelled to put on record their gratitude to the present directors of the House of Macmillan for the entirely free hand given them in guiding the policy of *Nature* and in deciding what shall and what shall not be published. To-day, as much as ever, if *Nature* feels that in the interests of science and culture, any book, whether published by Macmillans or not, should receive adverse criticism, then it gets it. If *Nature* desires to follow a certain policy where science is concerned, whether it be against or in support of other authorities, even the Government, then her policy is pursued relentlessly, yet, we hope, with tolerance. The directors never interfere with policy. Rather do they encourage the journal in all manner of ways, some of which have not received the recognition in the past that they deserved. In fact, it is quite possible that had the former directors not been prepared in the interests of scientific development to publish *Nature* for several decades at a financial loss, *Nature,* as we now know it, might not be in existence.

To-day, financial problems do not exist, and the considerable help given during the present very difficult times (especially of paper shortage and other exigencies of war) by the directors and their staffs certainly relieve the present editors of a considerable amount of care, and thus contribute in no small way towards the advancement of science in general and the success of *Nature* in particular.—*Nature.*

SCIENTIFIC BOOKS

ZOOLOGY

Osteology and Myology of the California River Otter. By EDNA M. FISCHER. Stanford University Press. 1942. 66 pp. 37 figures. $1.50.

Here is a brief description of this animal in preparation for a comparative study of the sea otter. It is an offset publication and excellently done.

The Ivory-billed Woodpecker. Research Report Num-

ber 1 of the National Audubon Society, New York. 111 pp. 20 plates. 22 figures. 1942. $2.50.

We find here an interesting account of the ecology and natural history of a bird threatened with extinction. It is by a graduate student and represents an effort to devise means for the preservation of the species. It is very full and detailed and ends with a series of recommendations to improve the conditions under which the bird will have to live.

The Oceanic Tintinnoina of the Plankton Gathered during the Last Cruise of the Carnegie. By ARTHUR SHAKLETON CAMPBELL. Carnegie Institution of Washington Publication 537. 163 pp. 128 figures. 1942. $1.50.

This is an extended account of a group of ciliate Protozoa, including discussions of 13 subfamilies, 44 genera and 311 species. Of these there are 3 new subfamilies, 2 new genera and 14 new species. They were collected at 160 stations on the Pacific and Atlantic Oceans. Four general regions are recognized.

The Heterodontid Sharks: Their Natural History and the External Development of Heterodontis japonicus Based on Notes and Drawings by Bashford Dean. By BERTRAM G. SMITH. The Bashford Dean Memorial Volume Archaic Fishes. New York. 649–770 pp. 7 plates. 70 text figures. 1942. $5.00.

In this volume is found some of the results reached by Dean in his studies of these fish. There is first a comparison of the various species, followed by an account of habits and development. Only a small part of the work is by Dean. The drawings are attributed to him, although it is stated that some of them were done by Yatsu. While it is evidently desirable to retain Dean's connection with this work it is perhaps unfortunate that the material could not be treated unreservedly. Still, it is a useful piece of work well presented, and it is only to be regretted that Dean's original idea of comparison could not be fully carried out.

The Copepods of the Plankton Gathered during the Last Cruise of the Carnegie. By CHARLES B. WILSON. Carnegie Institution of Washington Publication 536. 237 pp. 1942. $2.50.

There are given here the results of an extensive series of collections, made at three levels of the ocean and at 162 stations. A long line of species is studied in their relation to temperature, salinity, hydrogen ion concentration and light. There is first listed the species at each individual station, followed by a detailed consideration of each species. From these we learn that the Pacific plankton is much the richer. Also that in distribution there is horizontally no uniformity and that vertically the species are stratified. According to temperature the concentration was greater at the lower, cooler levels. Salinity and hydrogen ion concentration have little effect on distribution of animals. On the other hand light is a direct cause of vertical stratification.

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CHEMICAL AND PHARMACEUTICAL COMPOUNDS

Preparacion de Productos Quimicos y Quimico-Farmaceuticos. By C. A. ROJAHN and F. GIRAL. 2 volumes. 1002 pp. Published by Editorial Atlante, Mexico, D. F., Mexico.

DR. C. A. ROJAHN, director of the School of Pharmacy and of the Institute of Food Chemistry in the University of Halle, had published in German reviews of pharmacy and pharmaceutical chemistry for some years a series of articles on the preparation of chemical and pharmaceutical compounds. These articles were completed and published in book form in 1937. Dr. F. Giral, a young Spanish professor of organic chemistry, now residing in Mexico, has translated the original German book into Spanish and increased its value by adding to it 120 compounds, among which are some war gases, lead tetraethylate, sulfanilamide and prontosil, ergosterine, nicotinic acid and digitoxin. The book describes the preparation of 718 compounds, of which 217 are inorganic and 501 organic. It includes the most important industrial and pharmaceutical chemicals and among them the most important aliphatic, aromatic, hydroaromatic, heterocyclic compounds, dyes, alkaloids and glycosides. The author gives for each compound the following details: formula and molecular weight, raw materials and equipment necessary for its preparation, method, chemical reactions involved, yield, properties, assay and bibliography. The methods of preparation are described in such a way that they can be very easily followed by the student. The style is certainly not meant for the highly specialized chemist.

The book is essentially practical and will be found useful by students of chemistry and pharmaceutical chemistry and by the pharmaceutical concerns of the Latin American countries.

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REPORTS

DOCTORATES IN SCIENCE

FOR many years Dr. Clarence J. West, then of the National Research Council, edited an annual list of doctoral dissertations in the various fields of the sciences, most of which lists were published in the *Reprint and Circular Series* of that council.[1] During the 1933–34 academic year the National Research Council, the Social Science Research Council and the American Council of Learned Societies agreed to join in providing subsidies to the Association of Research Libraries in order to enable it to publish a complete list of all doctoral dissertations accepted in the United States and Canada each year. Dr. West generously surrendered his series to Mr. Donald Gilchrist, who began the new series under the title "Doctoral Dissertations Accepted by American Universities."[2] Mr. Gilchrist died suddenly, from a heart attack, just as No. 6 was going to press. The present writer was elected editor in December, 1939, and has edited three annuals bringing the series to nine.

The editor of SCIENCE has asked him to prepare this report regarding dissertations in the sciences. It is a study of what the nine annual volumes group as five physical sciences, seven earth sciences, fourteen biological sciences and anthropology, which is included here because it appeared in Dr. West's list of sciences and also because it is on the border line between the biological and the social sciences.

Table I herewith shows these twenty-seven fields of science arranged in order of the total number of dissertations accepted in the last nine years in each field. This table is unfair to just one field—biochemistry. In only five years it has attained eighth place in the table though all other totals cover nine years. If all the sciences were ranked on the basis of the last five years only, biochemistry would be in third place, well above psychology. And this leads to a word of caution to any one who would draw conclusions from this table. In general, the editor enters the dissertations under the particular science specified by the university reporting. Many institutions report many theses under "agriculture," which might well be classified in such fields as horticulture, entomology, etc. We allow the institutional designation to stand. In like manner, several dissertations which are obviously entomology were reported as "zoology." We allowed that to stand. However several institutions report blocks of dissertations as, "biology." The editor is forced to classify these on the basis of his understanding of the titles. Further, there are several overlapping fields such as geology and paleontology; anatomy, physiology and medicine and surgery. Different institutions vary in their classification of dis-

TABLE I

DOCTORAL DISSERTATIONS ACCEPTED IN THE SCIENCES

Rank	1934	1935	1936	1937	1938	1939	1940	1941	1942	Totals
1 Chemistry	500	470	482	497	426	482	527	672	588	4644
2 Physics	121	150	147	158	148	165	148	191	146	1374
3 Psychology	104	101	118	112	108	123	120	117	125	1028
4 Zoology	111	113	132	98	102	102	112	125	110	1005
5 Botany	117	110	108	88	106	108	112	102	120	971
6 Mathematics	82	77	84	76	62	91	103	95	85	755
7 Physiology	68	76	83	103	66	59	70	77	66	668
8 Biochemistry*	...	...	...	...	101	127	130	116	138	612
9 Engineering	97	63	48	70	59	44	77	76	47	581
10 Agriculture	62	77	53	48	37	40	58	78	55	508
11 Geology	55	62	64	42	58	49	55	53	56	494
12 Bacteriology and Microbiology	51	38	41	46	40	56	59	71	69	471
13 Entomology	34	34	30	51	33	47	48	46	44	367
14 Genetics	16	10	21	13	31	32	26	31	23	203
15 Pharmacology	15	10	18	14	19	23	23	31	31	184
16 Horticulture	9	24	14	21	16	11	20	23	21	159
17 Anatomy	10	25	15	14	20	17	21	18	16	156
18 Anthropology	10	13	20	15	18	11	26	19	14	146
19 Geography	17	15	8	13	13	17	18	16	16	133
20 Public Health	10	4	13	9	15	8	15	15	14	103
21 Metallurgy	13	11	16	7	7	9	11	17	11	102
22 Medicine and Surgery	18	14	12	1	7	9	10	13	15	99
23 Paleontology	8	12	10	8	9	13	11	11	6	88
24 Astronomy	11	11	5	9	12	5	6	11	7	77
25 Mineralogy	6	1	5	3	5	1	4	3	6	34
26 Meteorology	2	1	0	1	4	2	0	1	3	14
27 Seismology	3	2	0	0	0	0	2	1	1	9
Totals	1,550	1,524	1,547	1,517	1,522	1,651	1,812	2,029	1,833	14,985

* Biochemistry was introduced into our tabulations as a separate science in 1938. Before that date all biochemistry dissertations were grouped with chemistry.

[1] For a complete list of these reports, see "Doctoral Dissertations Accepted by American Universities," No. 1, 1933–34, p. iii.

[2] No. 1, 1933–34 (N. Y., H. W. Wilson Co., 1934).

TABLE II

NUMBER OF DOCTORAL DISSERTATIONS ACCEPTED

Rank		1942	Totals
1	Chicago	114	799
2	Wisconsin	97	795
3	Cornell	82	769
4	Michigan	66	685
5	Illinois	79	684
6	Columbia	74	684
7	California	88	649
8	Minnesota	86	619
9	Ohio	75	586
10	Harvard	58	534
11	Mass. Inst. Tech.	59	502
12	Yale	52	471
13	Iowa St. Coll.	60	454
14	Iowa	53	446
15	Johns Hopkins	43	411
16	New York	38	307
17	Calif. Inst. Tech.	28	266
18	McGill	36	257
19	Princeton	21	248
20	Toronto	26	243
21	Northwestern	27	231
22	Penn. St. Coll.	29	227
23	Pennsylvania	37	222
24	Stanford	24	214
25	Purdue	41	206
26	Maryland	28	175
27	Pittsburgh	23	160
28	Texas	19	146
29	Washington (Seattle)	11	145
30	Duke	14	136
31	Virginia	11	133
32	Brown	17	124
33	Nebraska	19	121
34	Indiana	16	121
35	Missouri	11	115
36	Cincinnati	11	114
37	Rochester	13	109
38	North Carolina	18	108
39	Rutgers	16	104
40	Catholic	22	101
41	Colorado	12	96
42	Western Reserve	8	86
43	Michigan St. Coll.	8	83
44	Kansas	3	82
45	Notre Dame	12	78
46	Washington (St. Louis)	9	75
47	Clark	10	64
48	Southern California	9	63
49	Lawrence (Inst. Paper Chem.)	8	60
50	Fordham	7	52
51	Rensselaer	5	50
52	Massachusetts	6	48
53	Louisiana	6	46
54	St. Louis	6	44
55	Boston	3	40
56	Rice	3	39
57	Florida	5	38
58	Carnegie Tech.	6	35
59	Brooklyn Polytech.	10	34
60	George Washington	2	34
61	Syracuse	0	34
62	Bryn Mawr	7	33
63	Radcliffe	5	33
64	Oregon St. Coll.	6	32
65	George Peabody	4	32
66	West Virginia	3	32
67	Georgetown	1	25
68	Kentucky	2	22
69	Washington St. Coll.	0	22
70	Vanderbilt	1	19
71	Tulane	3	16
72	Oklahoma	1	16
73	Kansas St. Coll.	6	15
74	Arizona	1	15
75	California (L. A.)	7	14
76	American	0	12
77	Colorado Mines	0	9
78	Marquette	1	8
79	Oregon	1	4
80	North Dakota	0	4
81	Temple	2	3
82	Hartford	1	2
83	Niagara	0	2
84	Tennessee	0	2
85	Smith	0	1
86	Georgia	0	1
87	Dropsie	1	1
88	Loyola (Chicago)	0	1
		1,833	14,985

sertations in physical chemistry, also in mathematical physics.

Table II shows from whence came these 14,985 dissertations in the sciences. It shows eighty-eight institutions which have accepted such dissertations arranged in order of the total numbers accepted by each in the last nine years. Some, such as Tennessee, no longer grant any doctorates. Others, like Hartford and Dropsie, are primarily theological but appear here because of one or more dissertations in psychology or in anthropology.

The order would be quite different if doctorates in the social sciences and the humanities were included. Space forbids the printing of the entire table showing the number of dissertations accepted in each subject each year. That number does not vary much from year to year, so we show only the numbers accepted in 1942 and the totals for the nine years.

Table III is not complete. The figures shown are the number of different fields of science in which each accepted one or more dissertations in each year. It is arranged by averages for the nine years and shows only those eighteen institutions which accepted dissertations in an average of approximately ten different sciences each year. These figures are interesting only upon the assumption that the various institutions have strong faculties in the various scientific fields in which they accept doctoral dissertations. In the cases of the schools omitted from Table III, the number of fields is so small and varies so much that the figures have no significance.

It is interesting to observe in Table III how great state universities outrank Chicago, Columbia, Yale, Harvard and Johns Hopkins in the number of science fields in which they accept doctoral dissertations. This would not be true if the social science and the humanities fields were included in the tabulations. It is also interesting to observe how close the University

TABLE III

NUMBER OF DIFFERENT SCIENCES IN WHICH DOCTORAL DISSERTATIONS WERE ACCEPTED

		1934	1935	1936	1937	1938	1939	1940	1941	1942	Average
1	California	16	17	15	15	17	15	20	21	18	17+
2	Michigan	16	16	16	16	18	16	18	17	19	17-
3	Wisconsin	14	14	16	15	16	19	16	18	19	16+
4	Minnesota	17	14	13	16	15	17	19	17	17	16+
5	Cornell	13	12	15	15	18	17	17	17	16	16-
6	Chicago	15	15	13	14	15	15	16	16	16	15
7	Columbia	13	12	12	16	14	14	18	15	13	14+
8	Yale	13	16	12	12	14	15	14	14	16	14
9	Illinois	15	13	13	14	12	15	14	16	12	14-
10	Ohio	14	10	12	12	12	12	13	17	14	13-
11	Harvard	13	11	11	13	12	13	12	10	14	12+
12	Johns Hopkins	13	9	9	12	14	15	11	9	12	12-
13	Iowa	11	9	10	12	12	10	12	11	13	11+
14	Iowa St. Coll.	8	10	11	11	10	13	12	13	12	11+
15	Toronto	11	8	10	12	8	11	13	13	7	10+
16	New York	9	10	8	8	9	11	13	9	13	10
17	Pennsylvania	9	10	10	11	9	9	12	11	9	10
18	Stanford	8	8	12	9	10	11	9	12	9	10-

of Iowa and Iowa State College stand in both Table II and Table III, while Pennsylvania State and Michigan State with an average of about five fields each per year are so far behind their respective state universities that they are excluded from Table III.

Perhaps the most interesting observation from all the tables is that of the entire 14,985 dissertations almost one third were written in the field of chemistry, or well over one third if we include those in biochemistry. Another observation is that well over one third of all the dissertations (5,684 out of 14,985) were accepted by the first eight institutions in Table No. II. Verily we are in an age of chemistry which is dominated by a few great universities.

Any one interested in seeing the titles of these dissertations should consult a file of the nine annuals. These titles reveal the particular lines along which research is being pressed to-day.

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SPECIAL ARTICLES

THE INTEGRATION OF GENETIC AND EPIDEMIOLOGICAL METHODS OF ANALYSIS IN RHEUMATIC FEVER[1,2,3]

IN previous genetic and epidemiological studies of a series of rheumatic families, it was concluded that hereditary factors are primarily responsible for the familial concentration of rheumatic fever. It was postulated that genetic susceptibility for rheumatic fever is transmitted as a single autosomal recessive gene. It was also indicated that age susceptibility must be considered in the study of the familial epidemiology of rheumatic fever.[4,5]

In order to analyze the interaction of the genetic and epidemiological aspects of rheumatic fever, analytical techniques were developed which permit a numerical description of the sequence of events in a group of rheumatic families.

In classical genetic analysis, the final number of cases is estimated by the application of appropriate genetic formulae. In this study, the methods were extended by predicting the final number of cases in the families prior to the time when all the children present who could eventually become cases had an opportunity to be realized. Such a prediction represents an average estimate of the number of genetic susceptibles present in the families at the time of analysis.

This procedure permits the expression in numerical terms of the genetic risk for a group of families, an individual family, or for members within a family group at any time during their life experience. Within a family, the genetic risk or factor may be divided equally among all siblings, or apportioned unequally with respect to any specific variable such as age, sex or exposure.

It is obvious that in rheumatic fever, where the peak age of onset in children occurs at about 6 years of age, the current age risk for a two-year-old child or a twelve-year-old child is less than that for his six-year-old sibling. In order to apportion the genetic risk with respect to this age risk, a numerical measure of the age expression of rheumatic fever was obtained.

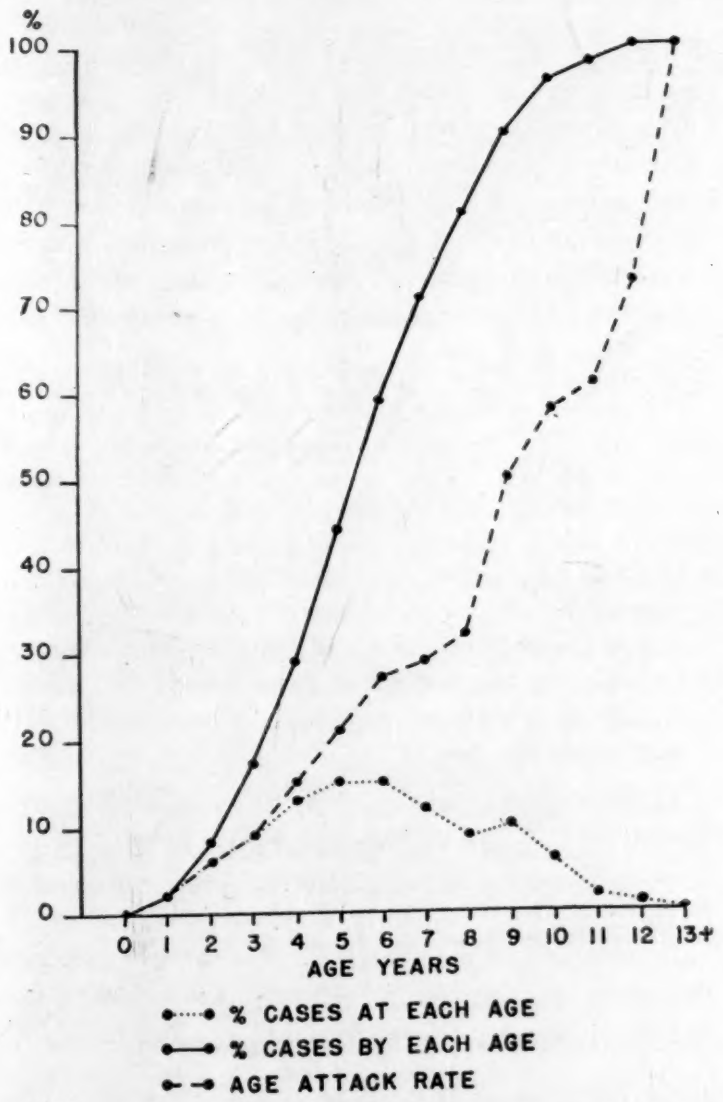

FIG. 1. Age factors derived from a rheumatic series of 688 case onsets.

[1] From the New York Hospital and the Department of Pediatrics, Cornell University Medical College.

[2] This work was aided by a special grant from the Commonwealth Fund.

[3] We gratefully acknowledge our indebtedness to Dr. Lowell J. Reed for his continued interest and constructive criticism during the progress of these studies.

[4] M. G. Wilson and M. D. Schweitzer, *Jour. Clin. Invest.*, 16: 555, 1937.

[5] M. G. Wilson, "Rheumatic Fever." New York: The Commonwealth Fund, 1940. Chapter III, pp. 21–65.

From an independent series of 688 rheumatic children whose onsets occurred between the ages of 2 and 13 years, several standard expressions of case incidence were derived which were found valid by analysis for defining the age risk under various circumstances (Fig. 1).

Using age and genetic factors in combination, it was possible to estimate the number of case onsets expected at various times during the life experience

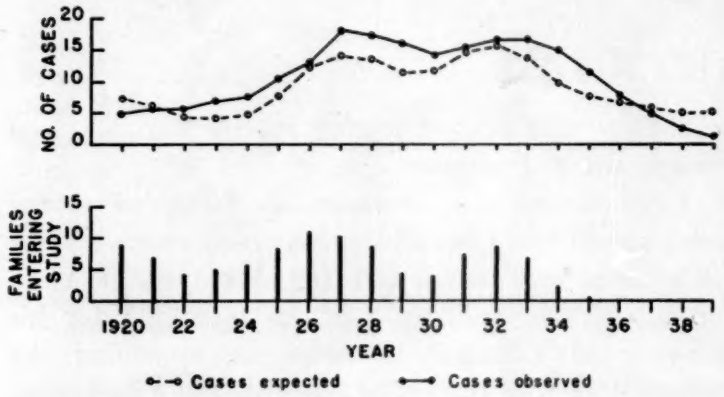

FIG. 2. Annual incidence of cases expected and observed during a twenty-year period, 1920–1939, in 102 rheumatic families.

of a group of 109 rheumatic families, including 456 rheumatic and non-rheumatic siblings.

The annual incidence of case onsets over a period of twenty years from 1920 to 1939 was estimated. Good agreement was obtained between expectation and observation (Fig. 2). It is apparent that in each year the total number of individuals defined by this procedure as genetic susceptibles of a susceptible age were realized as cases.

The general procedure was to assign to each sibling an equal fraction of the total final genetic expectancy for his family, correcting this for age in each calendar year using the cumulated age factor. Siblings were entered from the calendar year in which the families first came under observation. Siblings born subsequent to this year were entered at birth. In order to obtain the number of cases expected in any year, the total cumulated expectancy for the year preceding was subtracted from that of the current year, giving the annual expectancy. Case onsets were treated similarly.

In a communicable disease the occurrence and distribution of primary and secondary cases in a family is of epidemiological significance. The primary case in the family is frequently a source of exposure for other members of the household. Some observers have suggested that in rheumatic fever an active case constitutes a risk for the other siblings in the family.[6, 7]

[6] R. L. Gauld and F. E. M. Read, *Jour. Clin. Invest.*, 19: 393, 1940.

[7] A. Rosenblum and R. L. Rosenblum, *Am. Heart Jour.*, 23: 71, 1942.

When age and genetic factors were used to estimate the number of primary and secondary cases expected in this series of families, adequate agreement was obtained between cases expected and actually observed. In 59 families where both parents were negative, 57.92 primary and 43.61 secondary cases were expected when 60 and 41 cases, respectively, were observed. Similar agreement was found in the group of families where one parent was rheumatic. It is apparent that the risk for susceptible children to develop rheumatic fever is no greater before or after the onset of a case.

The primary and secondary cases expected were estimated as follows:

At the time of onset of the primary case, there is a specific sampling problem, since regardless of which siblings are genetically susceptible in the families, no cases have occurred up to the time of analysis. The total genetic expectancy for the family was apportioned unequally according to the age chance for each sibling to be the first case, using the age incidence factor. The actual number of primary cases expected was obtained by the application of the age attack rate factor.

The prediction of secondary cases was obtained by the direct use of simple genetic ratios corrected for current age risk using the cumulated age incidence factor.

In these analyses by the simultaneous application of age and genetic factors, the intrafamilial pattern of spread of rheumatic fever in 109 families was described in numerical terms. It is of epidemiological significance that during a period of twenty years, the annual incidence of cases and the occurrence of primary and secondary cases were satisfactorily estimated in these families on an age and genetic basis. It is apparent that whatever the nature of the agents responsible for the onset of the disease in genetic susceptible children at a susceptible age, they were uniformly operative at all times during the life experience of these families.

Interpretation of the fundamental basis for these findings must be speculative. It is reasonable to consider that the genetic risk is primary. It is possible that the age risk is inherent in the genetic risk. However, it is more likely that the age risk is secondary, reflecting the interval of time necessary for the expression or development of manifest disease.

The integration of genetic and epidemiological methods of analysis is an approach hitherto not formulated for rheumatic fever. The methods described may be utilized to evaluate etiologic concepts as well as prophylactic measures. Their usefulness in these studies suggests that their extension to other comparable problems of investigation may be profitable.

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THE EFFECT OF URINARY CORTIN-LIKE MATERIAL ON CARBOHYDRATE METABOLISM[1]

PREVIOUSLY we demonstrated that urinary extracts are capable of increasing the resistance of adrenalectomized rats to low environmental temperatures[2] as well as maintaining the lives of adrenalectomized rats.[3] Using glycogen deposition in the liver of the fasting adrenalectomized rat, we have now found that these extracts are able to influence carbohydrate metabolism in a fashion similar to that demonstrated for cortin and certain cortical compounds.[4,5]

The experimental procedure employed was a modification of the technique described by Reinecke and Kendall.[6] Adrenalectomized rats (140–160 gms) were fasted for 24 hours from the third to fourth day after operation. At the end of this period, the urinary extract was administered by stomach tube. Samples of the livers were removed and analyzed for glycogen by the method of Good, Kramer and Somogyi.[7] The urinary extracts used in this study are similar to those already described.[2,3]

In experiment A, the equivalent of 2 liters of urine dissolved in 1 cc of a 10 per cent. ethanol solution was administered once at 0 hours and again at 3.5 hours. The time of the termination of the 24-hour fast was reckoned as zero time. Samples of liver were removed between the seventh and eighth hours. In experiment B, the equivalent of 1.5 liters of urine dissolved in 1 cc of a 10 per cent. ethanol solution was administered at 0, 2.25, 4.5 and 6.75 hours. Samples of liver were removed between the eighth and ninth hours. All controls received 1 cc of a 10 per cent. ethanol solution at the hours indicated.

The results are presented in Table 1, in which the liver glycogen values are expressed in mgs of glycogen per 100 gms of liver (mg per cent.). The mean liver glycogen concentrations of those animals receiving urinary extracts were increased 5 and 10 times, respectively, for experiment A and B as compared with the controls. It is evident, therefore, that these urinary extracts influence carbohydrate metabolism in much the same way as do adrenal cortical extracts.

TABLE 1

THE INFLUENCE OF URINARY EXTRACTS ON THE DEPOSITION OF LIVER GLYCOGEN IN FASTING ADRENALECTOMIZED RATS

Experiment	Total urinary equivalent administered per rat in equal doses (liters)	Total volume of solvent (10 per cent. ethanol) administered (cc)	Times of administrations after completion of 24 hr. fast (hrs.)	Number of rats	Mean glycogen in liver (range) (mg. per cent.)
A	0	2.0	0 ;3.5	5	15.5 (13.9–19.0)
	4.0	2.0	0 ;3.5	5	75.4 (21.1–128)
B	0	4.0	0 ;2.25 ; 4.5 ;6.75	3	16.4 (12.5–19.3)
	6.0	4.0	0 ;2.25 ; 4.5 ;6.75	7	178 (60.9–308)

BENJAMIN N. HORWITT
RALPH I. DORFMAN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

NON-VIRULENT FROZEN AND DRIED ANTIGENS FOR COMPLEMENT-FIXATION TESTS WITH CENTRAL NERVOUS SYSTEM VIRUS INFECTIONS

Two steps have already been taken in developing a specific, practical complement-fixation test for diagnosing central nervous system virus infections. The first was the production of antigens from infected brain tissue which, under stated conditions, gave specific and duplicable results;[1] the second was the rendering of the antigens non-virulent in order to make them safe for general use in hospital diagnostic laboratories.[2] We wish now to describe a third step, namely, the successful freezing and drying of small quantities of non-virulent antigens, thus permitting their distribution by central production laboratories and their use over relatively long periods of time.

Standard virulent antigens were prepared[1] by obtaining infected mouse brains, making them into a 10 per cent. suspension with diluent in a mechanical homogenizer, centrifugalizing the material at 2,500 r.p.m. in a horizontal centrifuge, freezing and thawing

[1] From the Brush Foundation and Department of Biochemistry, Western Reserve University School of Medicine, and Department of Medicine, Lakeside Hospital, Cleveland, Ohio. Supported in part by a grant from the Josiah Macy, Jr. Foundation.

[2] R. I. Dorfman, B. N. Horwitt and W. R. Fish, SCIENCE, 96: 496, 1942.

[3] R. I. Dorfman and B. N. Horwitt. In press.

[4] S. W. Britton and H. Silvette, *Am. Jour. Physiol.*, 100: 693, 1932.

[5] C. N. H. Long, B. Katzin and E. G. Fry, *Endocrinology*, 26: 309, 1940.

[6] R. M. Reinecke and E. C. Kendall, *Endocrinology*, 31: 573, 1942.

[7] C. A. Good, H. Kramer and M. Somogyi, *Jour. Biol. Chem.*, 100: 485, 1933.

[1] J. Casals and R. Palacios, SCIENCE, 93: 162–3, 1941; *Jour. Exp. Med.*, 74: 409–26, 1941.

[2] J. Casals, *Proc. Soc. Exp. Biol. and Med.*, 49: 501–4, 1942.

it, and finally centrifuging it at 5,000 r.p.m. in an angle-head centrifuge and discarding the sediment. These preparations were then rendered non-virulent by exposure to the rays of a mercury arc lamp for a determined period of time.[2]

Freezing and drying of these antigens are accomplished in the following manner. The irradiated antigen is freed of sediment by centrifugation in a horizontal centrifuge for 10 minutes at 2,500 r.p.m. To the clear supernatant, merthiolate in a dilution of 1:10,000 is added. The antigen is then pipetted in 2 or 5 cc quantities into glass ampoules, frozen quickly by immersion into a dry ice-alcohol mixture, and dried over a period of 20 hours in a Flosdorf-Mudd apparatus,[3] after which the ampoules are sealed. The ampoules containing the desiccated antigen in an air-free space are stored at 2° C. When needed for use in tests the ampoules are opened and 2 or 5 cc of distilled water added to the desiccated material. A similar method was employed by Smadel and Wall for preserving spleen lymphocytic choriomeningitis antigen.[4]

In the following table the results of one test with an ampoule of irradiated frozen and dried Western equine encephalomyelitis antigen are shown. The figures in the first column indicate that the titer of the complement was the same with frozen and dried as with standard virulent antigen or saline control (0.13 cc), showing that the dried material was not anti-complementary. Column 2 indicates that the titer of dried and virulent antigens was the same, 1:8, showing that there was no loss of antigenicity from irradiation or freezing and drying. Finally, column 3 indicates that the fixation titer was the same in hyperimmune serum, whether virulent or frozen and dried antigen was employed.

Similar antigens with St. Louis and West Nile viruses have been prepared and tested. They have proved practically identical to the virulent antigens in antigenicity and specificity. Our observation of their keeping qualities is limited thus far to 6 weeks, but we believe that in view of universal experience with lyophilized materials, these antigens will maintain their specific properties for long periods of time.

TABLE 1

EFFECT OF IRRADIATION AND FREEZING AND DRYING ON THE COMPLEMENT-FIXING ANTIGEN OF WESTERN EQUINE ENCEPHALOMYELITIS VIRUS

(Antigen irradiated for 100 minutes; tested for virulence by intracerebral inoculation into Swiss mice. Out of 12 mice inoculated none died).

Antigen	Anti-complementary power*	Antigenicity†							Specificity and titer of serum‡							
		1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:1	1:2	1:4	1:8	1:16	1:32	1:64	1:128
No antigen; saline control	0.13 cc								0	0	0					
Western equine encephalomyelitis, non-irradiated .	0.13 cc	4¶	4	4	4	0	0	0	4	4	4	4	4	4	1	0
Western equine encephalomyelitis, irradiated and lyophilized	0.13 cc	4	4	4	4	0	0	0	4	4	4	4	4	4	2	0
West Nile, irradiated and lyophilized	0.13 cc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Amount of guinea pig serum in dilution of 1:30 equivalent to one unit.
† Dilution of antigen reacting with a constant amount of Western equine encephalomyelitis mouse immune serum.
‡ Dilution of Western equine encephalomyelitis mouse immune serum reacting with a constant amount of antigen.
¶ 4 = Complete fixation; 0 = complete hemolysis; 1, 2 = intermediate degree of hemolysis.

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[3] Earl W. Flosdorf and Stuart Mudd, *Jour. Immunol.*, 29: 389–425, 1935.

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